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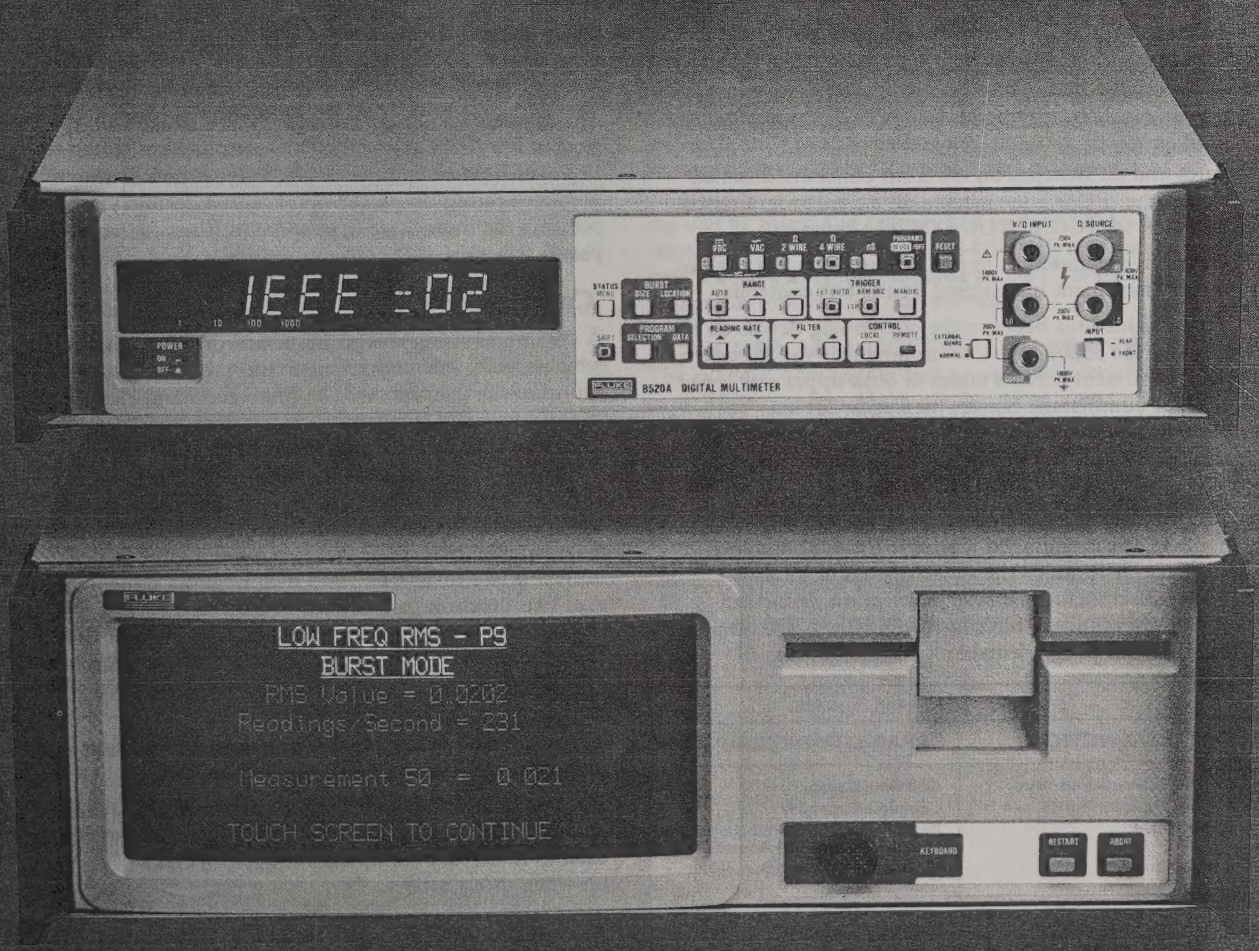
Technical Data

8520A Timing Characteristics B-0108



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Introduction

This technical bulletin outlines the remote operation of the 8520A. The data available should allow the user to determine specific times to process commands, trigger, compute, and output data via the IEEE-488 instrument bus. The scope of this technical bulletin should allow a novice programmer to remotely trigger and transmit readings and an expert to use the 8520A to its full capability.

Part I — PROGRAMMING

General

The 8520A is designed to operate in a system environment, via the integral IEEE-488 interface. When operated through the IEEE-488 Bus the instrument goes to remote, the front panel (REMOTE) indicator illuminates and all switches on the front panel are disabled except the (POWER) switch and, unless programmed disabled, the (CONTROL LOCAL) keyswitch.

Once the instrument is in the remote state, full control of the instrument is exercised by the bus controller.

Communications between the controlling device on the bus and the 8520A must be in standard ASCII code. The instrument accepts codes in both upper and lower case for commands. Spaces (hex code 20) may be inserted in a command string to improve clarity and readability but they are ignored by the instrument.

IEEE-488 Status

Each 8520A is equipped with a IEEE-488 standard interface. It contains the subsets listed in Table 1-1. Each subset includes a brief description. If further details are required, refer to the IEEE std. 488, Digital Interface for programmable Instrumentation.

Table 1-1. IEEE-488 Subsets

ID FUNCTION	CAPABILITY DESCRIPTION
SH1 Source Handshake	Complete Capability
AH1 Acceptor Handshake	Complete Capability
T5 Talker	Basic Talker, Serial Poll, Talk Only Undress at My Listen Address
L4 Listener	Basic Listener, Unaddress at My Talk
SR1 Service Request	Complete Capability
RL1 Remote/Local	Complete Capability
PP0 Parallel Poll	No Capability
DC1 Device Clear Interface	Complete Capability
DT1 Device Trigger Interface	Complete Capability
C0 Controller	No Capability
E2 Electrical Interface	Three-state drivers

When the instrument is turned on (POWER pushed to ON) or RESET is pushed twice, the 8520A will display the IEEE-488 Status. Table 1-2 lists the possible IEEE Status displays.

Table 1-2. IEEE Status

DISPLAY	STATUS
IEEE=(address,0-30)	IEEE Address of the 8520A
IEEE=OFF	The Untalk or unlisten setting is set to the illegal address 31. The 8520A will not respond to IEEE commands.
IEEE=TON	Talk Only switch is at ON
IEEE=BRK	IEEE-488 interface is nonoperational

The toggle switches on the rear, switch bank (S103), next to the IEEE connector, are used to change the IEEE address or operate in talk only. A new setting is only recognized on power-up or with a double reset (by pressing the reset twice in succession from the front panel).

Command Strings

A command string is a group of one or more commands which specify the measurement and processing configuration of the instrument. The final command character of the command string must be a terminator (or execution) command. It delimits the string and initiates processing of each command by the instrument. Command strings are stored in and executed sequentially from a buffer within the instrument. Up to 64 command characters including terminators may be stored into the buffer. If two or more entries deal with the same item; e.g., two function instructions or two reading rate instructions, both are executed, however, the last one executed determines the final state of the instrument.

Immediate Characters

There are three immediate characters that interrupt any measurement in progress for immediate action.

An immediate character may be executed at any time and does not require a termination character. They are used to reset, halt continuous trigger, or clear the RSV bit when using SRQ.

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***-RESET**
The instrument is reset to the default state with the (*) character, i.e., 100 volt dc range, a reading rate of two readings per second, a filter settling time of 500 ms, internal trigger, burst size =1, math programs off, SRQ off, and all miscellaneous commands enabled.
Default states: V R3 D8 F5 T0 M0 P0 B1 S0000 N1 N2 N3 N4 N5 N6 N7
See note below.

%-HALT
The halt character, represented by a percent sign (%), immediately stops any measurement in progress, clears the output buffer, and initiates processing of any commands within the command buffer.

This command is necessary to exit operation when operating an internal continuous trigger mode, (T0).

NOTE: After either the (%) or (*) are acted upon, they are stored as one ASCII character, without <CR><LF>, in the output buffer. Before further data is available, the (%) or (*) should be transferred from the DMM. Subsequent activity may be initiated, such as triggering a reading or recalling data without clearing the output buffer of this byte, but any data from the meter will be preceded with a (%) or (*).

&-"RSV" CLEAR
The clear RSV character (&) clears the internal request for service bit in the serial poll response byte. This bit is only set when operating with SRQ. The final byte of any 8520A response also clears the RSV bit.

Termination Characters

Termination characters cause the execution of a command string. When one is received, all commands in the buffer preceding the terminator will be processed in the sequence in which they were entered.

Each command is processed sequentially, first to last, the last being the final termination character. As a command is executed, it is removed from the command buffer. The time to process and configure each command is shown in Appendix A. The total processing time is the sum of each individual command processing time. Sample calculations are shown in Appendix B.

When sending long strings of commands, care should be taken not to exceed the 64-character limit of the command buffer. If this is exceeded, an error 07-IEEE will occur indicating the buffer overflow, and all commands not processed will be cleared from the buffer. This can be caused by sending too long of a command string, multiple command strings faster than the 8520A is processing them, not using termination characters, or operating in continuous trigger without using the Halt (%) command.

,-EXECUTE THE COMMAND STRING
The execute the command string character (,) will cause the execution of the previous command string. It does not trigger a reading, or arm a trigger for a reading. It does cause the execution of the "transmit" (GF, GM, GS, GR) commands which do generate output from the 8520A.

?-EXECUTE, TRIGGER AND TRANSMIT
The execute, trigger and transmit character (?) will cause the execution of the previously entered command string (if any), take a reading and transmit that reading to the IEEE interface. If a command string was not entered immediately preceding the (?) character, a reading will be taken and transmitted in the 8520A's current state. If a "transmit" (GF, GM, GS, GR) command is issued before a (?), the response to the (?) is the data requested, followed by the new reading.

!-EXECUTE, ARM TRIGGER AND TRANSMIT
The execute, arm trigger and transmit character (!) will cause the execution of the previously entered command string (if any), arm the BNC trigger, and transmit the triggered reading to the IEEE interface. If a command string was not entered previously, the 8520A will arm the trigger and transmit the triggered reading after the trigger occurs. If a "transmit" (GF, GM, GS, GR) command is issued before a (!), the response is the data requested, followed by the reading when triggered.

A (?) or (!) is required and will start the internal trigger mode (T0).

Function Instructions

The function instructions (Table 1-3) correspond to the function keyswitches on the front panel. Programming a function causes several other events to occur automatically. These result in automatic autoranging (R7) (ignored for the nanosiemens function), reading rates of 2 readings per second (D8), 500 ms (FAST for high ohms or nanosiemens) filter settling time (F5), programs off (M0), and normal speed (N5). Autorange begins with the 100V or 10K ohm range (R3) for all functions except nanosiemens, which has only the one fixed range (100 nS).

Table 1-3. Function Instructions

CODE	FUNCTION
V	Volts DC
VA	Volts AC
VC	Volts AC + DC
Z2	Ohm 2-Wire
Z3	Nanosiemens
Z4	Ohm 4-Wire

Range Instructions

The range instruction codes are listed and explained in Table 1-4. R8 removes the instrument from autorange and locks (or fixes) it in its current range.

Table 1-4. Range Instructions

CODE	RANGE				
	VOLTS				
	VDC	VAC/VA+D	OHMS	nS	HI OHMS
R0	100 mV	Auto	10	*	No
R1	1	1V	100	*	No
R2	10V	10V	1000	*	No
R3	100V	100V	10K	*	No
R4	1000V	1000V	100K	100	Yes
R5	AUTO	AUTO	1M	*	Yes
R6	AUTO	AUTO	10M	*	Yes
R7	AUTO	AUTO	AUTO	*	If selected
R8	Fix	Fix	Fix	*	If selected

**All Nanosiemen range commands default to (R4).*

Reading Rate Instructions

Table 1-5 contains a list of the reading rate instruction codes and the rates at the various input line frequencies. Also included are the default filter settling times. Each time the reading rate is changed, the default filter is selected; however, the filter settling time may be altered from the default after the reading rate is selected. The 400 Hz reading rates are nominally the same as the 60 Hz from 1 per second to 1 per hour; however, they are actually 0.03% faster than shown in the table. Rates faster than 10 readings per second are available only when measuring dc voltages or low ohms (10k range and below).

If the desired reading rate cannot be achieved due to slow IEEE interface listeners, autoranging, running math programs, or having the front panel on at 240 readings per second, "rr too fast" will be displayed and the reading rate will compensate for the slowdown.

Table 1-5. Reading Rate Instructions

RR CODE	READING RATE AT INPUT LINE FREQUENCY 60 Hz	50 Hz	400 Hz	DEFAULT FILTER CODE
D0*(1)	Asynchronous > 200/s			F0
D1*(2)	240/s	200/s	228/s	F0
D2*(3)	120/s	100/s	114/s	F0
D3*	60/s	50/s	57/s	F1
D4*	40/s	40/s	38/s	F1
D5	20/s	20/s	19/s	F2
D6	10/s	10/s	9.5/s	F3
D7	5/s	5/s	4.8/s	F4
D8	2/s	2/s	1.9/s	F5
D9	1/s	1/s	1/s	F6
D10	30/m	30/m	30/m	F6
D11	12/m	12/m	12/m	F6
D12	6/m	6/m	6/m	F6
D13	2/m	2/m	2/m	F6
D14	1/m	1/m	1/m	F6
D15	30/hr	30/hr	30/hr	F6
D16	12/hr	12/hr	12/hr	F6
D17	6/hr	6/hr	6/hr	F6
D18	2/hr	2/hr	2/hr	F6
D19	1/hr	1/hr	1/hr	F6

* *Code selectable only when DC Volts or Low Ohms selected.*

(1) If configured in (D0), all filter commands, F1 through F6 are ignored.

(2) 4-byte binary (I4) and front panel blanking (I1) must be configured to operate at this reading rate.

(3) 4-byte binary (I4) must be configured to operate at this reading rate.

Filter Instructions

The filter settling times assigned to each filter instruction code vary with the function selected. Times for each code are listed in Table 1-6. Only a fast (F6) or slow (F5) filter is selectable for a high ohms selection. The times vary depending on the range selected with the maximum times 300 ms for fast and 4 seconds for slow. Table 2-1 for actual times.

Table 1-6. Filter Instructions

CODE	FILTER TIME SAMPLES	DCV/LO Ohms	ACV/AC+DC	HI Ohms/nS
F0	1	5 ms	100 ms	FAST
F1	4	25 ms	100 ms	FAST
F2	8	50 ms	100 ms	FAST
F3	16	100 ms	100 ms	FAST
F4	16	200 ms	200 ms	FAST
F5	64	500 ms	500 ms	FAST
F6	128	1000 ms	1000 ms	SLOW

Program Instructions

Program selection codes and titles are given in Table 1-7. Each listed instruction code calls the same program described in Section 7 of the Operator's Manual. Up to three programs can be entered, e.g., to select programs 4, 6 and 7 (P467), as part of an instruction string; however, (P0) and (P1) cannot be combined with others and only one of codes (P11), (P12), (P13), and (P14) should be included in the command. Anytime a (P) command is executed,the accumulating registers of the program specified are cleared.

Table 1-7. Program Instructions

CODE	TITLE	NOTE
P0	None	Cannot be stacked
P1	TEST	Cannot be stacked
P2	ZERO	
P3	External Reference	
P4	Offset, Scale, and Ratio	
P5	Percent Deviation	
P6	Peak Values	
P7	Limits	
P8*	Statistics	
P9*	Low Frequency RMS Volts	
P10*	dB Ratio	
P11*	RTD Temp. Conversion	Stack only 1 of P11-P14
P12*	80T-150C Probe	Stack only 1 of P11-P14
P13*	80T-150F Probe	Stack only 1 of P11-P14
P14*	Thermistor Conversion	Stack only 1 of P11-P14

**Available as Option -010*

Programs In USE/OFF Instructions

M0 - Math Programs Off
M1 - Math Programs On

Math Program Register Commands

There are two commands to enter and recall data from the math program registers.

GRr - Transmit Register r
To recall and transmit over the IEEE Bus the contents of a desired math program register, the (GRr) command is used. The (r) represents the register to be read; i.e. to recall the contents of Register 7.5 the number of readings that passed limits testing, (GR7.5,) would be sent. The register data is not displayed on the front panel.

KRr/v - Keep Data v in Register r
To enter a value into a math program register, the (KRr/v) command is used. The (r) represents the register and the (v) is the value; i.e. to enter 10.25 volts as a lower limit in the limits program, (KR7.2/10.25,) would be sent. The value (v) is terminated by another command or termination character.

Memory Commands

There are four commands to set burst size and recall burst memory readings from the 8520A.

Bn - Burst Size
Burst size may be remotely set using the (Bn) command. The (n) is the size of the burst and may be an integer from -999 to +999; i.e. to set a burst size of 20, (B20,) would be sent. The number (n) is terminated by another command or termination character.

GMn - Transmit Memory Location*
To recall and transmit a reading from burst memory, the (GMn) command is used. The (n) is the burst memory location represented by an integer from -999 to +999; i.e. to recall burst memory location 20, (GM20,) would be sent.

Wn/m - Transmit Memory from n to m*
To recall and transmit a sequence of readings stored in burst memory, the (Wn/m) command is used. The duplicate (m) are integers from +999 to -999 which represent starting (n), and ending (m), memory locations; i.e. to recall locations 1 through 20, (W1/20,) would be sent.

** If math is turned on, (M1), the math will act on each recalled reading. The readings are not displayed on the front panel. The output format is in ASCII (N4) or 4-byte binary (I4). If using burst memory in high speed mode (I5), the output is either ASCII or 4-byte binary with 4½-digit resolution.*

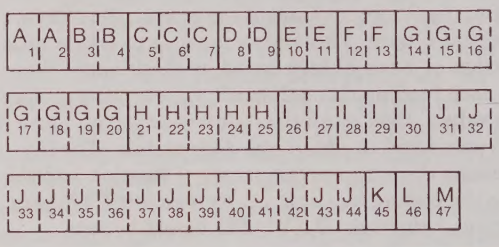
Yn/m - Scan Memory From n to m
To operate math on a sequence of memory locations without displaying or transmitting them, the (Yn/m) command is used. This allows the user to take a measurement or burst at high speed, without math, then scan each reading through math; i.e. statistics and/or peak values, then recall the required registers, using the (GR) command to obtain the desired data. The (n) represents the scan starting memory location and the (m) is the ending location; i.e. to scan burst memory locations 1 through 20, (Y1/20,) would be sent.

Status Commands

Two of the four status commands allow the operator to request and receive information on the status of the instrument. The other two are used to specify data to be used as an error or overrange response.

GF - Transmit Full Status
The full status of the instrument is transmitted over the IEEE-488 bus with the (GF,) command. This response provides the complete programmable configuration of the instrument in the form of a command string which would duplicate the configuration. It has embedded spaces to provide for all possible combinations of commands. The format, with the number of allotted characters per command is shown in Table 1-8. The string may be used at a later time to program the 8520A to duplicate this state, since it is terminated with a (,).

Table 1-8. Full Status Message Format



TOTAL CHARACTER	CHARACTER NO'S	FUNCTION
A 2	1-2	Function Code
B 2	3-4	Range Code
C 3	5-7	Reading Rate Code
D 2	8-9	Filter Code
E 2	10-11	Trigger Code
F 2	12-13	Programs In Use/Off Code
G 7	14-20	Programs Selected Codes
H 5	21-25	Burst Size
I 5	26-30	Serial Poll Codes
J 14	31-44	Miscellaneous Control Codes
K 1	45	Terminator (always a comma",")
L 1	46	Carriage Return
M 1	47	Line Feed (program selectable)

GS - Transmit Short Status

The short status command (GS) transmits the two-digit error code followed by a carriage return and optional line feed. The error codes defined in Table 1-9.

Table 1-9. Error Codes

ERROR	DISPLAY	EXPLANATION
00	Blank	No Errors
01	Err01 HV	High Voltage present with ohms function selected
02	None	Syntax error during remote operation
03	Err03 NOVR	Numeric or register overflow
03	Err03 RTD	Failure of RTD algorithm to converge
04	Err04 KEY	Invalid use of a control
05	Err05 FLTR	Cannot increase filter in ASYNC reading rate
06	Err06	ZERO (Math Program #2 cannot be selected with the VAC or VA+D function.
07	Err07 IEEE	IEEE-488 input buffer overflow
08	or VXRF	External Reference input > ± 16.5V dc with Math Program #3 selected.
09	ur VXRF	± 0.5V dc difference between EXTERNAL REFERENCE HI and LO terminals with Math Program #3 selected.
10	HHHHH (function)	Normal input overrange
11	Err11 HDWR	Improper echo from A/D Micro processor
12	rrtoo FAST	Reading rate too fast for selected filter and/or Math Program.
14	Err14 ROM	ROM check sum error
15	Err15 RAM	RAM does not check out
16	Err16 LINE	Cannot determine line frequency at POWER ON.
17	Err17 HDWR	Sync failure between the microprocessor and the A/D Converter.
18	OPEn INPT	V/Ω INPUT terminals not open during Analog Test (Math Program #1)
22	Err22 HDWR	Error while measuring volts for ohms change
23	Err23 HDWR	Time error, incorrect response from A/D Converter
24	Err24 HDWR	Resync error: instrument controller to A/D Converter
25	Err25 HDWR	Ohms Reference Error
30	Err30 UART	No A/D response to microprocessor within time limits
31	Err31 UART	Microprocessor detects parity error
32	Err32 UART	Microprocessor detects overrun error
33	Err33 UART	Parity and overrun errors (Error Codes 31 & 32)
34	Err34 UART	Microprocessor detects framing error
35	Err35 UART	Parity and framing errors (Error Codes 31 & 34)
36	Err36 UART	Overrun and framing errors (Error Codes 32 & 34)
37	Err37 UART	Parity, overrun, and framing errors (Error Codes 31, 32 & 34)
A1	ErrA3 GARD	Undefined interrupt at A/D
A3	ErrA3 GARD	Analog interrupt activated
A5	ErrA5 GARD	Parity, overrun, or framing error at A/D
A7	ErrA7 GARD	Illegal command A/D

KEs - Keep 's' as error response
To program an error response sent when an error occurs, the (KEs) command is used. The string, (s), can consist of up to 14 characters, but cannot contain an (*), (%), (,), (?), (&), or (!). 0 <CR> <LF>,) is the default value on power up. (KEerror <CR> <LF>,) could be used to alert an operator of the error.

KVs - Keep 's' as overrange response
To program an overrange response, to be sent when any overrange occurs, the (KVs) command is used. The string, (s), has the same restraints as above. 0 <CR> <LF> is the default value on power up. (KV99999 <CR> <LF>,) could be used to show an overrange condition.

Note: Reset does not affect the response. Use a (,) to terminate the string.

Miscellaneous Control Commands

There are 7 control commands which set up special configurations. The commands, shown in Table 1-10, are set to N1, N2, N3, N4, N5, N6, and N7 on power up and reset.

Table 1-10. Miscellaneous Control Commands

NUMERIC	ACTION	"N"	"I"
1	Front Panel	ON	OFF
2	Filter Time Out	ON	OFF
3	Line Feed	YES	NO
4	Code Format	ASCII	Binary
5	Speed	Normal	High
6	EOI	ON	OFF
7	Reading Transfer	LOCK	UNLOCK

N1/I1 - Enable/Disable Front Panel
When enabled, (N1), the display will operate and the local button will be active. When it is disabled, (I1), the keyswitches are not interrogated and the display is turned off, resulting in a local lockout type of condition. Front panel off, (I1), is used to increase speed at higher reading rates since the processor is no longer servicing the front panel.

N2/I2 - Digital Filter Timeout On/Off
The digital filter timeout to delay the start of a reading is enabled with the (N2) command. The times for digital filtering are shown in Table 2-1. Using (D0) or (I2) sets the timeout interval to zero. The Digital Filter Timeout allows for filter settling time, if the input is stable and speed is required the timeout may be disabled, (I2).

N3/I3 - Enable/Disable Line Feed
Enable line feed (N3), will transmit a line feed, <LF>, after the carriage return, <CR>, at the end of an ASCII output. Disable line feed, (I3), will suppress the line feed after the carriage return except on the error and overrange responses which are preprogrammed. A controller which terminates on <CR> will leave the <LF> 'hanging' in the output buffer.

N4/I4 - ASCII/4-Byte Binary Output Format
The decimal format of the measurement with 12 ASCII characters plus <CR> <LF> is set with the (N4) command. 4-Byte binary output format is set with the (I4) command. The 4-byte binary format (I4) is faster for data transfer but it must be converted for use, whereas the ASCII format may be used immediately, bub the 14-byte data transfer is slow. Table 3-6 and Table 3-7 explain the two formats.

N5/I5 - Normal/High Speed Reading Rate
To operate in high speed mode, the (I5) command is used. This sets the output format to 2-byte binary and the resolution to 14 bits, about 4½ digits. Speeds up to 520 readings per second may be achieved using the High Speed mode. The (N5) command is used for normal mode, with 5½ digits of resolution.

N6/I6 - IEEE EOI On/Off
EOI (End or identify) is an IEEE line used to indicate the end of a multiple byte transfer. If enabled (N6), the EOI line is activated with the last byte of each output. This signals the controller that all of the data has been transferred. EOI off (I6) may be used to enable buffering of multiple measurements without terminating the input operation.

N7/I7 - Reading Transfer Locked/Unlocked
To operate in internal continuous trigger, or external triggered burst, without transmitting each reading over the IEEE bus, (I7) unlocked reading transfer is used. This allows the generation of internal triggers within the 8520A. If operating in the locked mode (N7), each reading must be read over the IEEE bus to generate the next internal trigger. Part II, on triggering, discusses this in greater detail.

Serial Poll Commands

The service request function allows the 8520A to get the attention of the controlling device via the IEEE SRQ line. When this line is set, the controller, if enabled, will interrupt. Through a software service routine, the controller can perform a Serial Poll on each device to determine which device initiated the SRQ. The response of the device requesting service, during the Serial Poll, is a single byte with the RSV bit (#7), set true. Devices not requesting service will respond to the Serial Poll with the RSV bit (#7) set false.

The byte response from the 8520A includes not only the RSV bit (#7), but also status information explaining the reason for the SRQ. Table 1-11 lists the reasons why each bit of the Serial Poll response would be set. If the 8520A did not initiate the SRQ, the byte would be all zeros.

Table 1-11. Serial Poll Response

BIT	
8 (MSB)	0 (not used)
7	RSV (IEEE request for service)
6	Error (0004)
5	0 (not used)
4	Logical OR of the SRQ for Transmit Command (0004) New High Peak (0010) New Low Peak (0020) Reading High (0100) Reading Pass (0200) Reading Low (0400) LFAC Ready (2000)
3	End of Burst (0010)
2	Overrange (0020)
1 (LSB)	Output Ready (0001)

Sijkl - Serial Poll Command

The (Sijkl) command is used to instruct the 8520A to issue a SRQ. The (Sijkl) represents the items which will issue a SRQ. The code is configured by adding the codes for each SRQ item, shown in Table 1-2, together and precede the sum with an (S). In all cases, the leading zeros can be suppressed. Table 1-13 shows examples of common commands and responses.

Table 1-12. SRQ Configuring Codes

CODE	ITEM
0000	SRQ Disabled
0001	Output ready, Overrange, Error
0002	Overrange
0004	Error
0010	End of burst
0020	New high peak
0040	New low peak
0100	Reading High
0200	Reading Pass
0400	Reading Low
1000	Low frequency AC Reading Ready
2000	Undefined - do not use
4000	Undefined - do not use

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Table 1-13. Common (Sijkl) Commands and Responses

COMMAND CODE	REASON TO ISSUE SRQ	RESPONSES	
		HEX	DECIMAL
S0	SRQ disabled	00	0
S1	Output Ready, Overrange, or Error	41,42,60	65,66,96
S2	Overrange Only	42	66
S4	Error Only	60	96
S6	Overrange or Error Only	42,60	66,96
S10	End Of Burst	44	68
S11	End Of Burst or Output Ready	45	69
S12	End Of Burst or Overrange	42	69
S14	End Of Burst or Error	44,60,64	68,96,100
S16	End Of Burst, Overrange or Error	42,44,46,60	66,68,70,96
S20	New High Peak	48	72
S40	New Low Peak	48	72
S60	New High or Low Peak	48	72
S100	Reading High	48	72
S200	Reading Pass	48	72
S400	Reading Low	48	72
S500	Reading Fail (High or Low)	48	72
S501	Reading Fail, Output Ready, Error, Overrange	49,41	73,65
S502	Reading Fail or Overrange	48,42	72,66
S1000	Low Frequency AC Reading Ready	48	72

Part II - TRIGGERING

General

To initiate a measurement, a trigger must be received by DMM. There are primarily two methods of triggering measurements, they are external trigger and internal trigger.

Using the external trigger method, measurements are taken either under direct remote control, or through an external electrical trigger. The internal trigger method enables measurements to be triggered internally by the DMM without any external factors.

External trigger mode (T1) is preferred for remote operation because complete control of the measurement timing and synchronization is maintained by the system.

T0 - Internal Continuous Trigger Mode

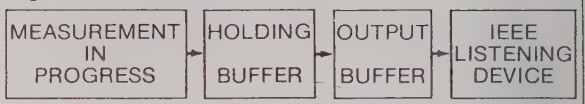
The internal trigger mode is primarily intended to achieve high measurement throughput. Individual triggering of each measurement is eliminated. Since triggering is done by the DMM, less control over measurement synchronization is obtained.

To operate in Internal Continuous Mode a (T0) command must be executed to select the mode. A subsequent (?) or (!) is required to start measurements.

Synchronous or asynchronous sample modes are selected with the reading rate instructions. (D1) to (D19) is used to select line frequency synchronous sampling and (D0) is for asynchronous sampling.

Using the normal mode of locked reading transfer (N7), all measurements must be accepted by the IEEE listening device.

Figure 2-1. Measurement Flow



After each measurement is completed it is moved to the Output Buffer and the next measurement is triggered. See Figure 2-1. The display will show the measurement held in the Output Buffer. If the Output Buffer is full (i.e. previous measurement not transferred to the Listener), the next measurement is stored in the Holding Buffer and another measurement is prevented until the data in the Output Buffer has been transferred. If the Listening Device cannot keep up, (i.e. using a printer in talk only, or using 14-byte ASCII format at 240 readings/sec) the front panel will display "rr too fast" and the actual reading rate will slow down. An error 12 will be stored in the error register, which can be recalled with the short status transmit command, (GS).

To continue taking measurements without transferring readings to the listening device, unlocked (I7) must be used. If the Output Buffer is full, the most recent measurement is stored in the Holding Buffer and is continuously updated with each new measurement. Each new measurement is displayed and written over the last measurement in the Holding Buffer. The measurement in the Output Buffer is not updated, therefore, two readings must be transferred from the DMM to get the most recent measurement.

To reconfigure and/or exit continuous trigger mode, the halt command (%), must be used. This will force the

```
10 INIT PORT 0                  !INITIALIZE PORT 0
20 PRINT @ 2;"VD6T0?"           !SET UP IN D.C. VOLTS
30                              !10 READINGS PER SEC
40                              !CONTINUOUS INTERNAL TRIGGER
50 INPUT @ 2;V$                 !TRANSFER MEASUREMENT FROM DMM
60 PRINT V$                     !DISPLAY READING ON 1720A
70 GOTO 50                      !GET NEXT MEASUREMENT
80 !
90 !    THE FOLLOWING WILL ALTER THE SAMPLE RATE TO (D3)
100!
110 PRINT @ 2;"%D3;"            !HALT AND CHANGE THE READING RATE
120 INPUT @ 2;TW$               !INPUT THE (%) FROM THE OUTPUT BUFFER
130 PRINT @ 2;"?"               !START CONTINUOUS INTERNAL TRIGGER
140 INPUT @ 2;V$                !TRANSFER MEASUREMENT FROM DMM
150 PRINT V$                    !DISPLAY READING ON 1720A
160 GOTO 140                    !GET NEXT MEASUREMENT
170 END
```

8520A to read the Input Buffer and clear the Output Buffer by storing a single ASCII (%) in it.

Examples of use with the Fluke 1720A and 8520A set to IEEE=2

T1 - Operation In External Trigger Mode

External trigger is configured when entering remote operation. The different methods of external triggering are (?), (!), GET.

? - Execute, Trigger, and Transmit

A (?) will process the preceding command string and trigger a reading to be output. A (?) may be sent individually to trigger single measurements.

! - Execute, Arm, BNC, and Transmit

A (!) will arm the rear BNC connector to allow external pulses to trigger readings. The pulse may be a rising or falling edge, TTL compatible, up to 30 volts or contact closure. The IEEE-488 address switch, S103, has a trigger toggle. When switched to the down position, a trigger will be recognized on the falling edge of a pulse or contact closure. When switched up, the rising edge or contact open will trigger a reading. All pulses must be greater than 100ns.

GET - Group Execute Trigger

The controller can issue a Group Execute Trigger (GET) at any time which will trigger a reading from the 8520A. "Any time" is defined as when the 8520A:

a. is in LOCAL, or
b. is expecting a ? or ! character, or
c. is in external trigger, not armed with "!", or
d. is in external trigger, armed, or
e. is in internal trigger, and
f. has fully processed any previous command strings.

When the 8520A receives a GET, it goes into external trigger mode (T1).

When GET is used, a delay is required following a command string, so that the processing of the command string can be completed. The length of the delay depends on the command string processing time. Command processing times are in Appendix A.

GET's sent too fast for the 8520A to handle are ignored.

The following examples use the 8520A in external trigger mode with the Fluke 1720A controller. The 3 methods of external trigger are shown.

```
10 INIT PORT 0                    !INITALIZE PORT 0
20 PRINT @ 2,"VF3T1,"             !D.C. VOLTS,100mS FILTER,EXTERNAL TRIGGER
30 PRINT @ 2,"?"                  !TRIGGER THE 8520A
40 INPUT @ 2,V$                   !TRANSFER MEASUREMENT FROM DMM
50 PRINT V$                       !DISPLAY MEASUREMENT ON 1720A
60 GOTO 30                        !TRIGGER NEXT MEASUREMENT
70 END
```

```
10 INIT PORT 0                    !INITALIZE PORT 0
20 PRINT @ 2,"VF3T1,"             !D.C. VOLTS,100mS FILTER,EXTERNAL TRIGGER
30 WAIT 10                        !WAIT 10 mS TO THE PROCESS COMMAND STRING
40 TRIG @ 2                       !TRIGGER A MEASUREMENT
50 INPUT @ 2,V$                   !TRANSFER MEASUREMENT FROM DMM
60 PRINT V$                       !DISPLAY MEASUREMENT ON 1720A
70 GOTO 40                        !TRIGGER NEXT MEASUREMENT
80 END
```

```
10 INIT PORT 0                    !INITALIZE PORT 0
20 TIMEOUT 0                      !DISABLE 1720A IEEE PORT ERROR TIMEOUT
30 PRINT @ 2,"VF3T1,"             !D.C. VOLTS,100mS FILTER,EXTERNAL TRIGGER
40 PRINT @ 2,"!"                  !ARM THE REAR BNC TRIGGER INPUT
50 INPUT @ 2,V$                   !TRANSFER BNC TRIGGERED READING FROM DMM
60 PRINT V$                       !DISPLAY MEASUREMENT ON 1720A
70 GOTO 50                        !WAIT FOR THE NEXT EXTERNAL BNC PULSE
80 END
```

Trigger Execution And Sampling Time

Once the 8520A has been configured, then it is ready to be triggered to take measurements. The time required to trigger, sample, process, and output measurements is determined by its configuration. The total time from a trigger to measurement output is the sum of each individual process involved.

The total time for trigger to output is:

$$T_{TP} + T_{55} + T_{WS} + T_{DF} + T_{AR} + T_{MP} + T_C = T_{total}$$

Examples are shown in Appendix B - Sample Computations.

Figure 2-2. Triggering and Filter Timing

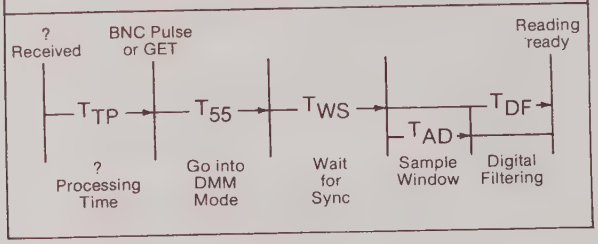


Figure 2-2 shows the time line for single triggering and digital filtering. An external trigger initiates the measurement process. This is either a (?, BNC Pulse, or GET). The (?) must be processed, (T_{TP}), from the command buffer, where as (BNC Pulse, and GET) is acted upon immediately. If any command strings had previously been received since the last measurement a 55 mS wait occurs, (T_{55}). When line synchronously sampling, (D1 to D19), a wait for sync., (T_{WS}), occurs while the 8520A waits for synchronization. The sample window, (T_{AD}), is the period when the input is connected to the Analog to Digital converter. When taking multiple samples, this window occurs for each sample. The Digital Filtering time, (T_{DF}), is the total period to take all of the samples and average them.

T_{TP} - ? Processing Time

When a (?) is sent, it must be processed from the Input Buffer and begin to execute the trigger.

The maximum processing times are:

T_{TP} = .951 ms with front panel on (N1)
T_{TP} = .588 ms with front panel off (I1)

T_{55} - Configuration To DMM Mode

The first reading following a command string will take an additional 55 ms. This only occurs with the first reading after reconfiguration (even if it is the same configuration). Subsequent ?'s, BNC Pulse's or GET's, if sent alone, will not have this additional time.

T_{55} = 55 ms after a command string
T_{55} = 0 ms after a previous trigger

T_{WS} - A Wait Sync

ASYNC External Locked (D0T1N7)
T_{WS}= .132ms to .138ms

ASYNC External Unlocked (D0T1I7)
T_{WS}= .137ms to .143ms

SYNC External Locked (DnT1N7)
T_{WS}= .400ms to 2.400ms

T_{AD} - Sample Window

T_{AD}= .407 msec per sample

T_{DF} - Digital Filtering

Table 2-1 shows the Digital Filtering time for each filter and line frequency combination with the filter time delay enabled (N2) or inhibited (I2).

In the normal mode of operation, timeout enabled (N2), the 8520A generates a delay to allow for analog filter settling. Example; The (F3) 100ms filter, at 60 Hz, averages 16 samples. With the timeout enabled (N2), it takes an 8 sample period delay (33.28 mS), then averages 16 samples (66.72 mS). If the timeout is inhibited, (I2), then no delay occurs and the Digital Filtering Time, (T_{DF}), would be for only 16 samples (66.72 mS).

Table 2-1. T_{DF} - Digital Filtering

FUNCTION	FILTER	SAMPLES/ READING	60Hz		50Hz		400Hz	
			N2	I2	N2	I1	N2	I2
VDC	F0	1	5 ms	4.17 ms	5 ms	5 ms	5 ms	4.37 ms
LOW	F1	4	25 ms	16.68 ms	25 ms	20 ms	26 ms	17.50 ms
OHMS	F2	8	50 ms	33.36 ms	50 ms	40 ms	52 ms	35.00 ms
VDC	F3	16	100 ms	66.72 ms	100 ms	80 ms	104 ms	70.00 ms
LOW	F4	16	200 ms	66.72 ms	200 ms	80 ms	209 ms	70.00 ms
VAC	F5	64	500 ms	266.88 ms	500 ms	320 ms	240 ms	280.00 ms
VA+D	F6	128	1000 ms	533.76 ms	1000 ms	640 ms	1048 ms	560.00 ms
HI OHMS	R4	16	100 ms	66.72 ms	100 ms	80 ms	104 ms	70.00 ms
nS	F5 R5	16	200 ms	66.72 ms	200 ms	80 ms	209 ms	70.00 ms
FAST F	R6	16	300 ms	66.73 ms	300 ms	80 ms	314 ms	70.00 ms
HI OHMS	R4	128	1000 ms	533.76 ms	1000 ms	640 ms	1098 ms	560.00 ms
nS	F6 R5	128	2000 ms	533.76 ms	2000 ms	640 ms	2096 ms	560.00 ms
SLOW F	R6	128	4000 ms	533.76 ms	400 ms	640 ms	4195 ms	560.00 ms

High Speed Mode
In High Speed Mode, asynchronous single measurements are taken.

T_{DF} = 1.93 ms

Part III — PROCESSING AND OUTPUT

Figure 3-1. Reading Processing

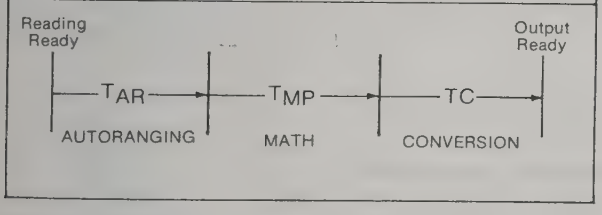


Figure 3-1 shows the processing time line. Once the samples are averaged, they are stored into burst, processed through any math programs, and converted to ASCII or binary output format. These times refer only to single external trigger. When operating in internal continuous trigger mode, the reading rate determines the rate of output. When running math programs while using internal trigger, the rate will slow down proportionally to the math program run times shown in Table 3-4.

TAR - Autoranging

Autoranging occurs when the reading is out of range and autoranging is enabled (R7). Autoranging actually occurs before the digital filter samples are taken, but is shown here for simplification. Table 3-1 shows points where autoranging occurs, or overrange error occurs, if in fixed range. Autorange decision occurs with each sample taken.

Table 3-1. Autoranging Levels

FUNCTION	RANGE	DOWN	UP
VDC VAC VA+D	100mV 1V 10V 100V 1000V	- < .15000 V < 1.5000 V < 12.000 V < 96.00 V	> 199.999 mV > 1.99999 V > 16.0100 V > 130.100 V > 1024.00 VDC > 650.00 VAC or VA+D
OHMS	10 100 1000 10K 100K 1M 10M	- < 15.000 < 150.00 V < 1.5000 K < 15.000 K < 150.00 K < 1.5000 M	> 19.9999 mV > 199.999 V > 16.0100 V > 1999.99 > 19.9999 K > 1.99999 M > 19.999 M
nS	100nS	-	> 202.00 nS

Auto Ranging In Volts

The time to autorange depends on the direction of change, the selected filter and whether the digital filter timeout is enabled (N2) or inhibited (I2). These times are shown in Table 3-2.

Table 3-2. TAR - Volts Autoranging Times

FILTER	1 RANGE UP	2 RANGES UP	3 RANGES UP	4 RANGES UP	ANY DOWN
N2 F0	140 ms	280 ms	420 ms	560 ms	140 ms
N2 F1	140 ms	280 ms	420 ms	560 ms	148 ms
N2 F2	140 ms	280 ms	420 ms	560 ms	157 ms
N2 F3	140 ms	280 ms	420 ms	560 ms	173 ms
N2 F4	140 ms	280 ms	420 ms	560 ms	273 ms
N2 F5	140 ms	280 ms	420 ms	560 ms	373 ms
N2 F6	140 ms	280 ms	420 ms	560 ms	606 ms
I2 F0	140 ms	280 ms	420 ms	560 ms	140 ms
I2 F1	148 ms	288 ms	428 ms	568 ms	140 ms
I2 F2	157 ms	297 ms	437 ms	577 ms	140 ms
I2 F3	173 ms	313 ms	453 ms	593 ms	140 ms
I2 F4	273 ms	413 ms	553 ms	693 ms	140 ms
I2 F5	373 ms	513 ms	653 ms	793 ms	140 ms
I2 F6	606 ms	746 ms	886 ms	1026 ms	140 ms

Auto Ranging In Ohms

When up ranging, the 8520A uses digital filtering (N2), even if (I2), filter inhibit, is called. The time to up range depends on the number of ranges plus the switching time to go into high ohms (R4, R5, and R6)

When down ranging, the 8520A drops in one step to the desired range. This time is dependent on the filter and the range dropping from and going to. The minimum and maximum times are shown in Table 3-3.

Up Ranging Times

152 ms per range + 429 ms to go from R3 to R4

Down Ranging Times

Table 3-3. T_{AR} Ohms Down Ranging

FILTER	MINIMUM	MAXIMUM
F0	142 ms	375 ms
F1	150 ms	388 ms
F2	160 ms	395 ms
F3	174 ms	410 ms
F4	278 ms	510 ms
F5	378 ms	610 ms
F6	611 ms	4080 ms

T_{MP} - Math Program Run Time

The time to run any math program is shown in Table 3-4.

Table 3-4. T_{MP} - Math Program Run Times

PROGRAM	FRONT PANEL ON (N1)	FRONT PANEL OFF (I1)
P0	1.75 ms	1.75 ms
P1	1.75 ms	1.75 ms
P2	2.00 ms	2.00 ms
P3	143 to 225 ms	143 to 225 ms
P4	4.00 ms	4.00 ms
P5	4.00 ms	4.00 ms
P6	3.10 ms	3.10 ms
P7	3.60 ms	3.60 ms
P8	19.5 ms	16.5 ms
P9	12.5 ms	10.9 ms
P10	19.0 ms	17.0 ms
P11	28 to 47 ms	24 to 42 ms
P12	4.50 ms	4.20 ms
P13	4.70 ms	4.50 ms
P14	19.1 ms	17.5 ms

The run time for multiple programs is obtained by adding each program run time together.

T_C - Time For Conversion

The time required to convert to ASCII or binary output format, set SRQ, if enabled, and ready the first byte for output is shown in Table 3-3.

Table 3-5 T_C - Convert To Output

T_C + 2.1 ms to 2.3 ms	14-byte ASCII format
T_C + .5 ms to .7 ms	2- & 4-byte binary format

Data Output Format

When a reading is transmitted, it can be used in one of four different formats as determined by the output format selected and program status. The formats are ASCII, four-byte binary (standard speed mode), two-byte binary (high speed mode), and math program special applications. Each format is further described below.

ASCII Format

The standard ASCII format contains twelve characters of data, a carriage return, and program selectable line feed. The output format begins with a sign, followed by seven characters of data, i.e., five and one-half digits of data, a floating decimal point (except for the 10 M Ohms and 100 nanosiemens ranges that have four characters to define the exponent, followed by the carriage return, and program selectable line feed. The exponents is in modified engineering notation, i.e., it appears only in multiples of three from E+00 up to E+18 and down to E-18. Refer to Table 3-6 for a format sample.

Table 3-6. ASCII Output Format

1	2	2	2	2	2	2	2	3	3	3	3	4	5
1	2	3	4	5	6	7	8	9	10	11	12	13	14

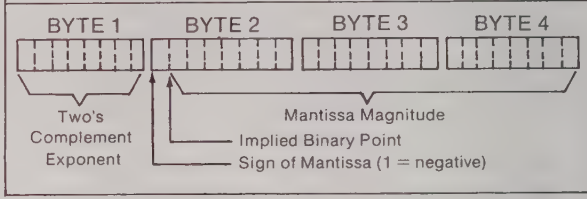
EXAMPLE: +18.5809E+00<CR><LF>

1 Sign (+ or -)
2 Reading absolute value. Floating decimal point designates range.
3 Exponent in modified engineering notation.
4 Carriage Return
5 Line Feed (program selectable.)

Four-Byte Binary Format

This format uses an implied binary point rather than using a character to represent the binary point. The meter uses un-normalized floating point arithmetic, which means the value of the mantissa ranges between -0.9999999 and +0.9999999. The four-byte format can only be used in the standard speed mode of operations. Only the two-byte format can be used for the high speed mode. The first byte is a two's complement exponent. The following three bytes represent a signed magnitude mantissa. Table 3.7 shows the four byte message format.-

Table 3-7. Four-Byte Binary Format



Conversion Formula

Step 1 Convert each byte to decimal
Step 2 A = (Byte 2)/128 + (Byte 3)/32768 + (Byte 4)/8388608
Step 3 If A< 1 Then A=A-1
Step 4 If (Byte 1)< 128 Then A = A*($2^{(Byte\ 1)}$)
Step 5 If (Byte 1) > 127 Then A = A*($2^{(Byte\ 1-256)}$)
Step 6 A = Measured Value

Example: Measuring A Positive Voltage

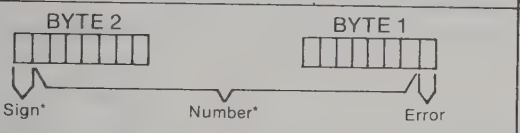
Byte 1	Byte 2	Byte 3	Byte 4
5	23	255	254

A = 23/128 + 255/32768 + 254/8388608 = 0.1875
A = 0.1875*(2^5)
A = 5.9999 Volts

Two-Byte Binary Format (High Speed Mode)

The two bytes of the high speed mode can be treated as a 16-bit binary number in the format shown in Table 3.8. If the message is treated as a 16-bit binary number, it can be converted to the decimal value using the methods also shown in Table 3-8. All conversions require that the fixed range be known. If the 16-bit binary number is odd, i.e. the LSB of byte 1 is a 1, the 8520A is in overrange and the message is a hexidecimal 29H (Byte 2) 0HH (Byte 1) for a positive overrange or A9H (byte 2) 00H (byte 1) for a negative overrange.

Table 3-8. 2-Byte Binary Format Output



Conversion Formula

Step 1 Convert both bytes to decimal
Step 2 A = (Byte 2)*(256) + (Byte 1)
Step 3 If A >=32768 Then A = A - 65536
Step 4 A = A/32768
Step 5 R = A*MR; R=Result in volts or ohms

MR=Multiplier Range

RANGE	VOLTS	OHMS
R0	100 mV = 0.25	10 = -25
R1	1V = 2	100 = -200
R2	10V = 16	1000 = -2000
R3	100V = 128	10K = -20000
R4	1000V = 1024	HIGH OHMS

Example: Positive Voltage 10V (R2) Range

Byte 1	Byte 2
0100 0010	0000 1001

Byte = 66, Byte 2 = 9
A = 9*256 + 66 = 2370
A = 2370/32768 = 0.0723
R = 0.0723*16 = 1.1568 Volts

Special Formats

Five special message formats are available for use with the math programs. If the Limits Program #7 is selected or is the last program performed from a group of programs, the response to a request for a reading is a three-character ASCII coded message plus a fourth character that is program selectable. The message begins with the sign and a one-character numeric code, followed by a carriage return and the program selectable line feed.

Table 3-9. Limits Program Output Format

CONDITION	ASCII FORMAT	BINARY FORMAT
HIGH	+2 <CR> <CF>	0000 0010
PASS	+1 <CR> <LF>	0000 0001
LOW	-1 <CR> <LF>	1111 1111

If the Display Option Register feature has been selected to display some register reading, the number of the register can be obtained by asking for a reading of the Display Option Register. The response will be the ASCII coded number of the register (e.g. 3.1, 6.3, 11.23, etc.) followed by a carriage return and the program selectable line feed.

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Appendix A-PROCESSING TIME

The function command processing time is dependent on the command line frequency and whether the front panel is on or off.

COMMANDS	60 HZ		50 HZ		400 HZ	
	ON(N1)	OFF(I1)	ON(N1)	OFF(I1)	ON(N1)	OFF(I1)
V	6.17 ms	5.33 ms	6.17 ms	5.33 ms	6.17 ms	5.33 ms
VA	25.50 ms	22.08 ms	24.78 ms	22.36 ms	25.50 ms	22.36 ms
VC	25.52 ms	22.09 ms	24.79 ms	22.37 ms	25.52 ms	22.37 ms
Z2	79.96 ms	69.68 ms	77.97 ms	70.30 ms	79.96 ms	70.30 ms
Z3	79.97 ms	69.69 ms	77.98 ms	70.40 ms	79.97 ms	70.40 ms
Z4	79.96 ms	69.68 ms	77.97 ms	70.39 ms	79.96 ms	70.39 ms

The configuration command processing time is dependent on the command and whether the front panel is on or off. Times shown are maximum worst case.

COMMAND	ON(N1)	OFF(I1)	COMMAND	ON(N1)	OFF(I1)
'	950 ms	—	%	10.525 ms	9.907 ms
?	.951 ms	.588 ms	I1	1.345 ms	.982 ms
!	.989 ms	.626 ms	N1	1.400 ms	1.037 ms
,	1.000 ms	.537 ms	I2	.955 ms	.592 ms
&	.637 ms	.274 ms	N2	1.010 ms	.647 ms
R0 R4(V)	3.608 ms	2.984 ms	I3	.955 ms	.592 ms
R5 R7(V)	1.255 ms	.892 ms	N3	1.010 ms	.647 ms
R8 (V, VA, VC)	1.215 ms	.852 ms	I4	.955 ms	.592 ms
R0 R7(VA, VC)	1.255 ms	.892 ms	I4	1.010 ms	.647 ms
R0 R6(Z2, Z4)	3.608 ms	2.984 ms	I5	1.005 ms	.642 ms
R7 (Z2, Z4)	1.255 ms	.892 ms	N5	1.045 ms	.682 ms
R8 (Z2, Z4)	1.215 ms	.852 ms	I6	.955 ms	.592 ms
D0 D19	3.358 ms	2.734 ms	N6	1.010 ms	.647 ms
F0 F6	.758 ms	.395 ms	I7	.955 ms	.592 ms
T0	.980 ms	.617 ms	N7	1.010 ms	.647 ms
T1	.962 ms	.599 ms	P0	1.654 ms	1.291 ms
M0	.860 ms	.487 ms	P1	(1)	
M1	.857 ms	.494 ms	P2	1.718 ms	1.355 ms
B1	1.477 ms	1.114 ms	P3	1.791 ms	1.428 ms
B+1	1.440 ms	1.077 ms	P4	1.863 ms	1.500 ms
B999	1.557 ms	1.194 ms	P5	1.935 ms	1.572 ms
B-999	1.543 ms	1.180 ms	P6	2.584 ms	1.818 ms
KE1	.955 ms	.592 ms	P7	2.703 ms	1.937 ms
KE0 <CR> <LF>	1.107 ms	.744 ms	P8	3.133 ms	2.509 ms
KV1	.970 ms	.607 ms	P9	2.941 ms	2.317 ms
KV0 <CR> <LF>	1.122 ms	.759 ms	P10	2.855 ms	2.231 ms
KR4.3/10	5.100 ms	4.116 ms	P11	2.923 ms	2.299 ms
KR14.6/123.456	15.814 ms	13.740 ms	P12	2.995 ms	2.371 ms
GM1	4.650 ms	3.430 ms	P13	3.067 ms	2.447 ms
GR4.1	6.830 ms	5.930 ms	P14	3.144 ms	2.520 ms
GS	2.810 ms	2.450 ms	GF	6.600 ms	4.700 ms

(1) Has output - time depends on transfer.

Appendix B - SAMPLE COMPUTATIONS

The following examples are sample calculations used to illustrate the steps necessary to determine the total time required to take a single triggered measurement.

Command String Processing Time

From Appendix A, the time to process each command from the buffer can be calculated by adding each command processing time together.

Example: Processing the Command String (VR2F3T1,) (60Hz, Front Panel on (N1))

V R2 F3 T1 ,

6.16 ms + 3.608 ms + .758 ms + .962 ms + 1.000 ms = 12.5 ms

Trigger To Output Time

The time from a single trigger to output ready is determined by adding the times from Part II and III together.

Example: (VR2F3T1,) (Configuration above)

Send (?) after processing the above command string.

T_{TP} T_{55} T_{WS}* T_{DF} T_{AR} T_{MP} T_C* TOTAL

.951 ms + 55 ms + 2.4 ms + 100 ms + 0 ms + 0 ms + 2.3 ms = 160.6 ms

The next (?) sent will not have the additional 55 ms wait.

.951 ms + 0 + 2.4 ms + 100 ms + 0 + 0 + 2.3 ms

= 105.6 ms

Example: Previous command string (Z2R4F5I1T1P6M1,)

Hi ohms, fast filter bypassed, external trigger, peaks program on

Sending a G.E.T. to trigger after the above command string has been processed and 1 reading taken, T_{55}=0.

T_{TP} T_{55} T_{WS}* T_{DF} T_{AR} T_{MP} T_C* TOTAL

0 + 0 + 2.4 ms + 66.72 ms + 0 + 1.6 ms + 2.3 ms

= 73 ms

**NOTE: The maximum times are used.*

High Speed Mode

External triggered high speed mode time from trigger to output ready.

Previous command string: (VR2I5T1,)

Using (?) to trigger;

T_{TP} T_{55} T_{WS} T_{DF} T_{AR} T_{MP} T_C TOTAL

.558 ms + 0 + .138 ms + 1.93 ms + 0 + 0 + .7 ms = 3.36 ms

Using GET or BNC Pulse to trigger;

T_{TP} T_{55} T_{WS} T_{DF} T_{AR} T_{MP} T_C TOTAL

0 + 0 + .138 ms + 1.93 ms + 0 + 0 + .7 ms = 2.77 ms

Readings Rates Using Math Programs

The reading rate slows down proportionally to the math program run time.

Using (D4), 40 readings per second, and Program 4 (P4).

D4 = 40/sec the inverse = 1/40 sec = 0.025 sec

P4 = 4 ms run time (T_{MP}, Table 3-4)

0.025 sec + 0.004 sec = 0.029 sec

The reading rate will slow to 1/0.029 sec = 34 readings per second.

Appendix C - SAMPLE PROGRAMS

```
10!*************************************************************************
20!*                                                                       *
30!*              8520A USING LIMITS PROGRAM FOR RESISTOR TESTING           *
40!*                                                                       *
50!*                 THIS PROGRAM USES PROGRAM 7 OF THE 8520A              *
60!*   TO DETERMINE IF THE MEASURED RESISTOR IS WITHIN 950ohms TO 1050ohms  *
70!*    IF IT PASSES IT WILL DISPLAY THE VALUE, OTHERWISE IT WILL DISPLAY   *
80!*            "FAILED HIGH" OR "FAILED LOW" ON THE FLUKE 1720A           *
90!*                                                                       *
100!************************************************************************
110!
120 INIT PORT 0                              !INITALIZE PORT 0
130 DV%=2                                    !SET THE 8520A IEEE ADDRESS = 2
140 PRINT @ DV%,"*Z2F4T1P7M1,"               !RESET, 2 WIRE OHMS, 200mS FILTER
                                             !EXTERNAL TRIGGER, LIMITS PROGRAM ON
160 PRINT @ DV%,"KR7.1/1050 KR7.2/950,"      !SET UPPER LIMIT TO 1050 OHMS
                                             !SET LOWER LIMIT TO 950 OHMS
180 INPUT @ DV%;TW$                          !INPUT THE (*) FROM THE OUTPUT BUFFER
190 K=KEY                                    !CLEAR "KEY"
200 PRINT"TOUCH SCREEN FOR EACH TEST"        !DISPLAY PROMPT
210 WAIT FOR KEY                             !WAIT FOR SCREEN TO BE TOUCHED
220 K=KEY                                    !CLEAR "KEY"
230 TRIG @ DV%                               !TRIGGER THE 8520A
240!
250!                LIMIT OUTPUT RESPONSE TEST
260!
270 INPUT @ DV%,A%                           !INPUT RESPONSE (2,+1,-1,0)
280 IF A%=2 THEN PRINT"FAILED HIGH"          !IF HIGH, DISPLAY "FAILED HIGH"
290 IF A%=1 GOTO 330                         !IF PASS, GOTO PASS ROUTINE
300 IF A%=-1 THEN PRINT"FAILED LOW"          !IF LOW, DISPLAY "FAILED LOW"
310 IF A%=0 GOTO 140                         !IF ERROR START OVER
320 GOTO 210                                 !RETURN FOR NEXT TRIGGER
330!
340!                       PASS ROUTINE
350!
360 PRINT @ DV%,"MOGM1,"                     !TURN MATH OFF, GET READING
370 INPUT @ DV%,R                            !INPUT THE READING
380 PRINT "PASS  R="iRi"OHMS"                !DISPLAY "PASS" AND READING VALUE
390 PRINT @ DV%,"M1,"                        !TURN LIMITS PROGRAM BACK ON
400 GOTO 210                                 !RETURN FOR NEXT TRIGGER
410 END
```

```
10 !************************************************************************
20 !*                                                                       *
30 !*                          8520A IN HIGH SPEED MODE                     *
40 !*                                                                       *
50 !*            THIS PROGRAM RUNS THE 8520A AT SPEEDS GREATER THEN         *
60 !*               500 READINGS PER SECOND  WITH THE FLUKE 1720A           *
70 !*                        USING RBYTE/WBYTE.                             *
80 !*                                                                       *
90 !************************************************************************
100 !
110 INIT PORT 0                              !INITIALIZE PORT 0
120 DV%=2                                    !SET 8520A IEEE ADDRESS TO 2
130 MR=16                                    !RANGE MULTIPLIER
140 DIM R%(999),D%(2)                        !DIM ARRAYS FOR RBYTE & WBYTE
150 PRINT @ DV%,"*VR2I5I6,"                  !RESET, VOLTS, 10 VOLT RANGE
160                                          !HIGH SPEED 2 BYTE MODE, EOI OFF
170 INPUT @ DV%,TW$                          !INPUT THE (*) FROM THE BUFFER
180 PRINT "CONNECT INPUT FOR 10VOLT DC RANGE" !DISPLAY PROMPT
190 PRINT "TOUCH SCREEN TO START READINGS"
200 K=KEY                                    !CLEAR "KEY"
210 WAIT FOR KEY                             !WAIT FOR THE TOUCH
220 D%(0)=544%+DV%                           !MLA, MAKE THE 8520A A LISTENER
230 D%(1)=63%                                !SEND A (?) TO START TRIGGERING
240 D%(2)=576%+DV%                           !MTA, MAKE THE 8520A A TALKER
250 WBYTE D%(0..2)                           !SEND THE (?)
260 RBYTE R%(0%..999%)                       !TAKE IN 1000 BYTES
270!
280!                    CONVERSION OF THE 500 READINGS
290!
300 FOR I% = 0 TO 999 STEP 2                 !LOOP TO READ THE ARRAY
310 V=(R%(1+I%)*256+R%(I%))                  !2nd BYTE * 256 + 1st BYTE
320 IF V>=32768 THEN V=V-65536               !POSITIVE OR NEGATIVE?
330 VF=V*MR/32768                            !MR=16 FOR 10 VOLT RANGE
340 PRINT (I%+2)/2!                          !DISPLAY READING NUMBER
350 PRINT USING "8###.###"; VF               !DISPLAY FORMATED READING
360 NEXT I%                                  !LOOP BACK FOR NEXT CONVERSION
370 END
```

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```
10 !*************************************************************************
20 !*                                                                       *
30 !*                 4-BYTE DATA OUTPUT FORMAT CONVERSION                  *
40 !*                                                                       *
50 !*       THIS PROGRAM USES THE 8520A IN 4-BYTE OUTPUT FORMAT TO TAKE     *
60 !*           10 READINGS AND DISPLAY THEM USING THE FLUKE 172OA          *
70 !*                                                                       *
80 !*************************************************************************
90 !
100 INIT PORT 0                          !INITALIZE PORT 0
110 DV%=2                                !8520A IEEE ADDRESS = 2
120 DIM R%(39),D%(2)                     !SET RBYTE & WBYTE ARRAYS
130 PRINT @ DV%,"*VFOI6I4T1,"            !RESET, VOLTS, 5mS FILTER, EOI OFF
140                                      !4-BYTE OUTPUT FORMAT, EXT. TRIGGER
150 INPUT @ DV%,TW$                      !OUTPUT THE (*) FROM THE OUTPUT BUFFER
160 K=KEY                                !CLEAR "KEY"
170 PRINT"TOUCH SCREEN TO START"         !DISPLAY PROMPT ON 172OA
180 WAIT FOR KEY                         !WAIT FOR THE SCREEN TO BE TOUCHED
190!
200!                    RBYTE & WBYTE COMMANDS
210!
220 D%(0)=544%+DV%                            !MLA, MAKE THE 8520A A LISTENER
230 D%(1)=520%                                !GET, TRIGGER THE 8520A
240 D%(2)=576%+DV%                            !MTA, MAKE THE 8520A A TALKER
250 RBYTE (WBYTE D%(0%..2%))R%(0%..39%):4     !WRITE 3 BYTES, D0, D1,& D2
260                                           !READ 4 BYTES INTO R%
270                                           !LOOP THROUGH 10 TIMES
280!
290!            LOOP 10 TIMES TO CONVERT THE 4 BYTES
300!                AND DISPLAY THE 10 READINGS
310! NOTE:EOI IS INHIBITED, SO IT IS NOT ADDED TO THE LAST BYTE
320!
330 FOR I%=0 TO 39 STEP 4
340 V=(R%(1+I%)/128)+(R%(2+I%)/32768)+(R%(3+I%)/8388608)
350 IF V>1 THEN V=1-V
360 IF R%(I%)<128 THEN VF=V*(2^(R%(I%)))
370 IF R%(I%)>127 THEN VF=V*(2^(R%(I%)-256))
380 PRINT USING 'S###.####', VF;"  VOLTS"
390 NEXT I%
400 END
```

```
10 !*************************************************************************
20 !*                                                                       *
30 !*                          SRQ AT END OF BURST                          *
40 !*                                                                       *
50 !*  THE 8520A WILL TAKE 200 READINGS INTO BURST AT 240 READINGS PER SECOND *
60 !*   SET SRQ AT END OF BURST, SCAN THE READINGS THROUGH ITS MATH PROGRAMS  *
70 !*             AND TRANSMIT THE RESULTS TO THE FLUKE 172OA               *
80 !*                                                                       *
90 !*************************************************************************
100 !
110 INIT PORT 0                          !INITIALIZE IEEE PORT 0
120 DV%=2                                !8520A IEEE ADDRESS = 2
130 PRINT @ DV%,"*VR2D1B200S1DT1I1I7,"   !RESET, VOLTS, 10V RANGE, 240 RDS/SEC
140                                      !BURST=200, SRQ ON END OF BURST
150                                      !EXT. TRIG., FRONT PANEL OFF, UNLOCKED
160 INPUT @ DV%,TW$                      !INPUT THE (*) FROM OUTPUT BUFFER
170 K=KEY                                !CLEAR "KEY"
180 PRINT"TOUCH SCREEN TO START BURST"   !DISPLAY PROMPT
190 WAIT FOR KEY                         !WAIT UNTIL THE SCREEN IS TOUCHED
200 TRIG @ DV%                           !TRIGGER THE 8520A
210 WAIT FOR SRQ                         !WAIT FOR SRQ AT END OF BURST
220 PRINT @ DV%,"P86M1Y1/200,"           !TURN ON STATISTICS AND PEAKS PROGRAM
230                                      !SCAN BURST MEMORY 1 THROUGH 200
240                                      !TO FIND THE AVERAGE, AND UPPER
250                                      !AND LOWER PEAKS
260 INPUT @ DV%,TW$                      !THROW AWAY 1st TRIGGERED READING
270 PRINT @ DV%,"GR6.2GR6.1GR8.2,"       !GET PEAKS AND AVERAGE VALUES
280 INPUT @ DV%,LP                       !INPUT LOW PEAK
290 INPUT @ DV%,UP                       !INPUT UPPER PEAK
300 INPUT @ DV%,AV                       !INPUT AVERAGE
310 PRINT "LOWER PEAK="!LP               !DISPLAY LOWER PEAK VALUE
320 PRINT "UPPER PEAK="!UP               !DISPLAY UPPER PEAK VALUE
330 PRINT "AVG. VALUE="!AV               !DISPLAY AVERAGE VALUE
340 END
```

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